Nutrient Management Newsletter for the Western U.S.

Nutrient Digest

VOLUME 7, ISSUE 1 — *A publication of the WERA-103 Committee** — SPRING, 2015

PHOSPHORUS UPTAKE AND REMOVAL BY BUSH BEANS. IS P FERTILIZATION A NECESSITY, REGARDLESS OF SOIL TEST P VALUE?

By Aaron Heinrich, Ed Peachey and Dan Sullivan. Oregon State University

Soil test phosphorus (STP) levels on processed vegetable farms in Oregon's Willamette Valley have increased over the past 30+ years. In 1978, median soil test P was 49 ppm via the Bray P-1 test (n=93; Jackson et al., 1978) vs. 91 ppm in recent years (n=32; Heinrich, unpublished). Interpretive values in the OSU snap bean fertilizer guide (OSU FG-28) reflect field research done prior to the early 1980s. Since then, bean varieties and other production practices have changed, possibly changing the minimum STP value needed for optimum bean yield and quality. When soil test values are high (above thresholds for P fertilizer response), P management goals need to be revisited. Soil test P does not change rapidly, taking 20 years or more for soil test P to decline from a value of 80 ppm to a value to 50 ppm, even with zero P fertilizer application. Knowledge of nutrient balance between inputs (fertilizer) and outputs (in this case snap bean pods) can assist farmers in reducing cost of production and in protecting nearby water bodies that may be sensitive to P as a pollutant. To prevent further increases in soil test P, accurate values for crop nutrient uptake and removal are needed.

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REDUCING AMMONIA EMISSIONS THROUGH DAIRY MANURE LAND INJECTION

By Lide Chen and Howard Neibling, University of Idaho

The volatilization of ammonia (NH_3) from animal manure is not only a loss of valuable nitrogen (N), but also causes air quality concerns. Land spreading of animal manure accounts for approximately one-third of the total NH_3 emissions from agriculture, so there has been much interest in the development of dairy manure land application techniques as industry best management practices (BMP) to abate NH_3 emissions. Direct injection incorporates manure directly beneath the soil surface and thus minimizes odor and NH_3 emissions during application. Two of the most common types of direct injection applications are liquid tankers with injectors and drag-hose systems with injectors. Manure can be successfully injected in both conventional tillage and non-till systems with currently available equipment.

What Did We Do?

On-farm manure application trials conducted at two sites were used two manure application methods: surface broadcast and subsurface injection (Figure 1). At both sites, a square plot of approximately one acre in the western portion of the site was used for surface broadcast and the rest of the land was used for subsurface injection. The western portion of the site was chosen because the prevailing winds were

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Head Editor – Amber Moore, University of Idaho; Guest Editor – Dan Sullivan, Oregon State University

Field monitoring studies were conducted in seven Willamette Valley farmer fields in 2014 to measure P uptake and removal by snap beans grown for commercial processing. Because P is typically less available in cold soils, fields planted from April to June were monitored. Average soil temperature at 3 inches ranged from 65 to 72 ^{o}F among fields, suggesting that temperature did not have a major influence of soil P availability. Preplant soil test P (Bray P1 method; 0-12 inches) was collected from each field. Cooperating farmers reported P fertilizer application rate, and bean plants were harvested from two areas within each field: a zero P plot (10 x 40 ft), and an adjacent area that was fertilized using grower practice. Fertilizer N and K were applied at the same rate in the adjacent grower-fertilized field and in zero P plots. Three subsamples of whole plants were collected from P fertilized and unfertilized plots for determination of bean yield and nutrient uptake in each field.

Fields with STP greater than 55 ppm showed no response to P fertilizer regardless of planting date. Two sites with STP of 34 and 41 ppm responded to P fertilization. At a site with STP of 34 ppm, pod yield increased by 113% with P fertilization (Fig. 1). At a site with STP of 41 ppm, plants were smaller without P fertilizer, but pod yields were not affected. At the other five field sites with STP above 55 ppm, crop yield or biomass did not respond to P fertilization.

Using a mass balance approach (fertilizer applied minus removal in harvested bean pods), an average of 93 lb P2O5/acre remained in the field at harvest, equivalent to 88% of the applied P. Total aboveground snap bean uptake was 27 lb P2O5/acre, of which approximately half was returned to the field as crop residue (Fig. 2). Fields fertilized with low N, high P analysis fertilizers such as 10-34-0 (Fields 4 through 7), had the highest rates of P application (130 to 160 lb P2O5; Fig. 2).

Phosphorus fertilizer response data coupled with a P mass balance helps explain why STP has been increasing on most Oregon processed vegetable farms. Although this is a small data set, it challenges current Oregon State University recommendations of applying 60-90 lb P2O5/acre even when STP is >60 ppm (OSU FG-28).

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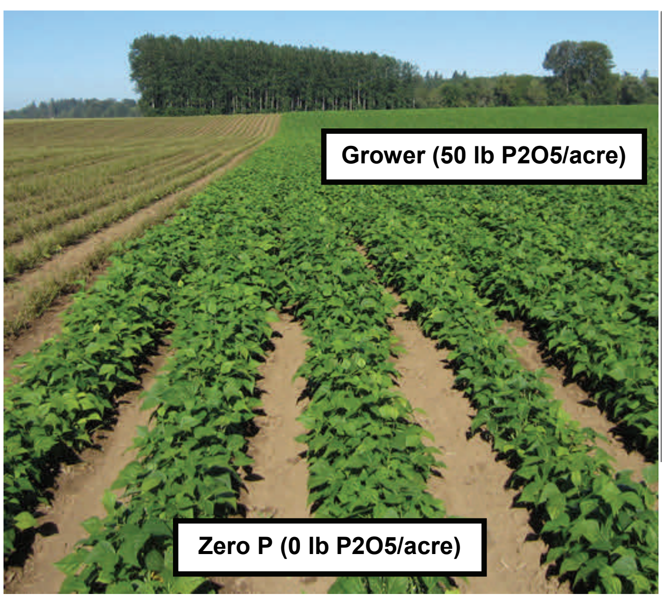

Figure 1. Response of snap beans to P fertilization in field #2 with a low value for soil test P (34 ppm via Bray P1 method). Beans responded to P fertilizer only in fields where soil test P was less than 55 ppm. Only 2 fields out of 7 grower fields monitored had soil test P < 55 ppm.

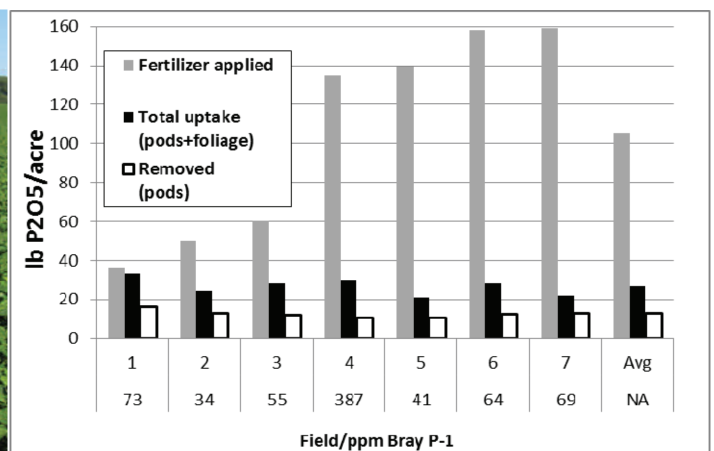

Figure 2. Applied P fertilizer, total P uptake (foliage and pods), and P removed from the field in the harvested product (pods) for snap beans grown in the Willamette Valley, Oregon at seven field sites (field ID #1 to #7 above). Preplant Bray P1 soil test values were 34 to 387 ppm. Two fields (#2 and 5) had preplant soil test P (STP; Bray P-1 method) <55 ppm. Plant subsamples collected from an unfertilized plot in grower fields showed no bean yield or plant growth benefit (vs. subsamples from adjacent grower-fertilized field) when STP exceeded 55 ppm.

Phosphorus Uptake and Removal by Bush Beans. Is P Fertilization a

The principles and research approach used in this study are applicable to most cropping systems. The Bray soil test is employed in western Oregon and Washington for acid soils, while other parts of the West use the sodium bicarbonate or Olsen test method for P. Soil test values for a Bray test are typically 1.5 to 2.5X greater than Olsen P test values in soils with near neutral pH (no carbonates). So a Bray value of 55 ppm (reported here) roughly corresponds to an Olsen test value of 20 to 35 ppm. Additional details from this research can be found at the *Oregon Vegetables* website: http://horticulture.oregonstate.edu/content/increasing-nutrient-use-efficiency-snap-beans-2014

References

Jackson, T.L, R. Bostdorf, and S. Bissel. 1978. Nutrient Survey, Sweet Corn, Willamette Valley. Available at: http://horticulture.oregonstate.edu/content/nutrient-survey-sweet-corn-willamette-valley-1978

Mansour, N.S., H.J. Mack, E.H. Gardner, and T.L. Jackson. 2000. Fertilizer Guide: Bush Beans, Western Oregon-west of Cascades. OSU Extension Publication FG 28.

Newly Revised Publication: FERTILIZING WITH BIOSOLIDS (PNW 508)

By Dan Sullivan, Craig Cogger, and Andy Bary. Oregon State and Washington State Universities.

This recently revised Pacific Northwest Extension publication highlights nutrient management practices for municipal biosolids application to cropland. The revised guide is based on research conducted over the last 20 years in Washington and Oregon. Dryland wheat and pasture cropping systems are most frequently used for biosolids application. Some cities now produce "Class A" biosolids products that have been treated to eliminate human pathogens, and can be marketed without regulatory permit. For example, some cities now produce Class A heat-dried biosolids that are pelleted, bagged and sold in lawn & garden fertilizer products.

Fertilizing with Biosolids includes:

- Guidelines for use of university nutrient/fertilizer guides in calculating nitrogen-based agronomic biosolids application rates.
- Typical biosolids nutrient content and fertilizer replacement value (based on plant-available N, P, K, and S supplied by biosolids).
- Current information on trace element concentrations in municipal biosolids vs. regulatory standards.
- Effect of biosolids application on soil pH and soil test P.
- Brief summary of long-term (15+ yr) field research studies conducted with dryland wheat (east of Cascades) and grass for silage (west of Cascades).
- Crops and situations where biosolids use is not appropriate (e.g. crops grown under USDA Organic certification).
- Questions and answers about biosolids safety, regulations, and other "big picture" issues

Fertilizing with Biosolids. PNW 508-E. Now available online: https://catalog.extension.oregonstate.edu/ 19 p.

Reducing Ammonia Emissions, cont. from pg 1

from the north during the test period. The previous crop at the two sites was corn; both sites had been disked after harvest.

Dairy manure used for the field tests was from a lagoon which contained about nine million gallons of manure at the beginning of the tests. Sludge had not been removed for five years. The manure lagoon was agitated before and during application with a floating mixing pump, effectively dislodging and mixing sludge into the liquid manure. Manure was pumped from the lagoon directly to the application field via drag hoses. The two manure application methods were demonstrated with the same equipment. Subsurface injection placed manure behind the equipment shanks in a band approximately 8 in. deep. Surface broadcast was achieved by lifting the shanks above ground to apply manure on the soil surface. After manure application, passive NH_3 samplers were installed on each of three towers spaced about 50 ft apart in a north-to-south orientation. The middle tower was placed at the center of the manure surface applied plot. Three towers were placed in the subsurface injected field parallel to the ones in the surface broadcast plot and approximately 660 ft apart to minimize cross-contamination between emissions from the two manure application methods. Another three towers were placed 165 ft upwind (north) of the site.

Ogawa passive NH_3 samplers (Ogawa USA, Inc., Pompano Beach) were used to determine the time-averaged concentrations of NH_3 at each sampling location. The passive NH_3 samplers were installed on each tower at heights of 1.6 and 3.2 ft to determine the NH_3 concentration at each location. The passive NH_3 samplers were changed approximately every 24 h over a two-day period after manure application.

For each test site, a grab sample (about 1 L) of liquid manure was collected and analyzed. The manure pH, total N, and calculated total N application rates are shown in Table 1. The liquid manure application rate on both test sites was approximately 20,000 gal/acre. Continued on page 6

Figure 1. Manure application method with drag hoses: a) subsurface injection and b) surface broadcast.

Table 1. Manure pH, total N concentration and application rate of total N at the two test sites.

Site	Manure pH	Manure total N concentration (mg/L)	Manure Total N Application Rate (lb/acre)
Site 1	7.4	3433	567
Site 2	7.3	3519	584

DON HORNECK MEMORIAL SCHOLARSHIP

Donald (Don) Horneck, Oregon State University Extension agronomist/soil scientist extraordinare, passed away suddenly on September 28, 2014 at his home in Irrigon, OR. He was 56. Don served Oregon and the Western Region via his research and Extension program. He joined OSU in 2000, following extensive experience as an industry agronomist and as manager of an analytical laboratory. He conducted research on irrigated potato, onion and numerous other crops in the Columbia Basin. He was widely regarded as an expert in soil test methodology, soil test intepretation, irrigation water quality, and many other topics of importance to Western agriculture. In recent years, he was well known for his research on reducing ammonia-N loss from broadcast N fertilizers. He held certifications as a Certified Crop Advisor (CCA) and a Certified Professional Soil Scientist (CPSS) since 1998. He was an active member of the WERA-103 Committee, the publisher of this newsletter. With WERA-103 members, Don assisted in planning eight regional nutrient management workshops and he co-authored the WERA-103 publication: *Soil, Plant and Water Reference Methods for the Western Region.* Don summarized some of his research findings on fertilizer products and ways to increase fertilizer use efficiency in recent *Nutrient Digest* newsletters.

Donations for the "Don Horneck Memorial Scholarship" are being collected by the Oregon State University Foundation. Funds will be used to support an undergraduate or graduate student working in agronomy or soil science at Oregon State University. To contribute, go to the OSU Foundation web page, click on “Making a gift” then click again on “Make a one-time gift” (or monthly contribution) and click on the either option of “Making a one-time gift” or “Making a pledge payment”. At that point fill in the blank on the figure amount and then under "Area you’d like to support” say "Don Horneck Memorial Scholarship".

Reducing Ammonia Emissions, cont. from pg 4

What Have We Learned?

Average NH_3 concentrations (Figure 2) during the two-day monitoring period across both the sites and sampling heights were 0.83, 0.27, and 0.22 mg NH_3-N/m^3 for the broadcast, injection, and background, respectively. There was a 68% decrease in NH_3 concentration when liquid dairy manure was applied by injection vs. broadcast. The results indicate the injection of liquid manure is an appropriate method to significantly reduce NH_3 emissions from land applied liquid manure and could be recommended as an industry BMP to reduce NH_3 emissions.

Ammonia concentrations averaged over height and site were 1.01/0.65 (Surface broadcast), 0.25/0.29 (subsurface injection), and 0.28/0.16 (Background) mg NH_3-N/m^3 for the first/second day, respectively. The highest NH_3 concentrations were measured during the first 24 h after manure broadcast. Ammonia emissions in the broadcast fields were reduced by 35% in the second day compared with the first day. This suggests that immediate incorporation of manure is required to reduce NH_3 emissions and that the sooner the incorporation occurs, the greater are the benefits in terms of NH_3 losses.

Take-home Messages

- Subsurface injection can reduce NH_3 emissions compared with surface broadcast; therefore, applying liquid dairy manure by subsurface injection could be recommended as one of the BMPs to control NH_3 emissions.
- The highest NH_3 emission rate from liquid dairy manure applied to land occurs immediately after manure application
- The NH_3 emission rate decreases dramatically during the first two days after application, indicating that immediate incorporation of manure is needed to reduce NH_3 emissions
- Therefore, the sooner the incorporation occurs, the greater are the benefits in terms of reduced NH_3 loses.

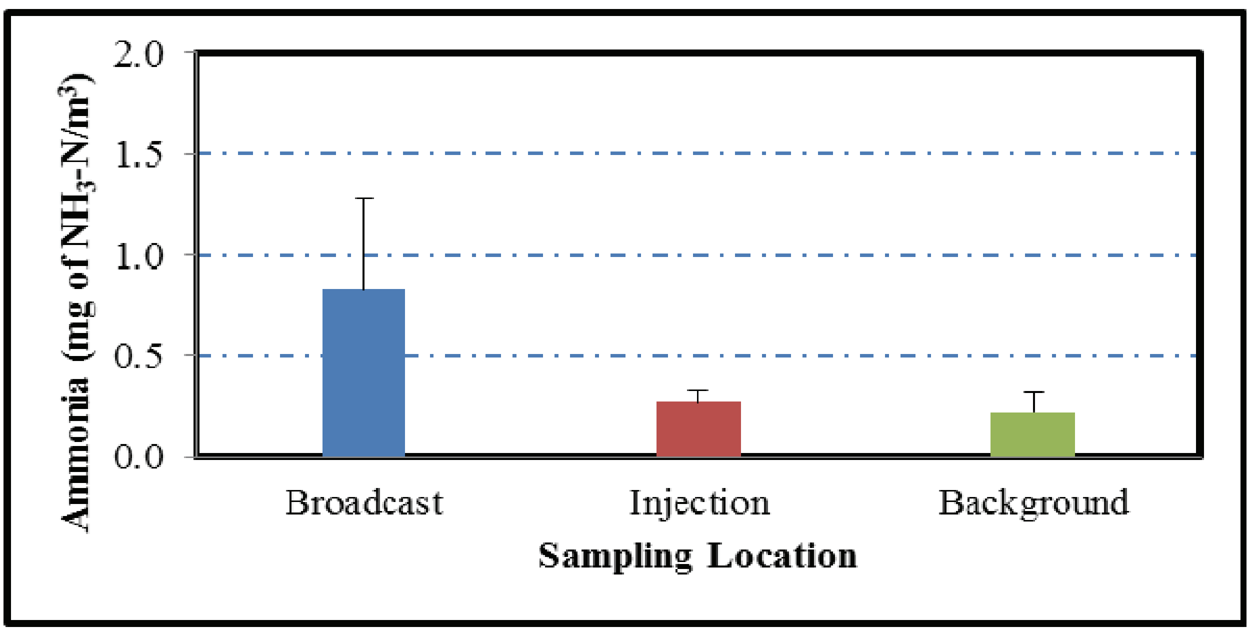

Figure 2. Effect of application method on ammonia-N concentration in the air for the first two days following dairy slurry application. Ammonia-N concentration was averaged across two sampling heights at two field sites.